LIFESAVING ADVANCES IN COMBAT CASUALTY CARE

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Introduction

Combat casualty care (CCC) is constrained by logistics, manpower, and the hostile operational environment. Although 70 percent of combat casualty wounds are not life-threatening, most will require medical intervention because even small wounds on the battlefield can degrade a soldier's operational effectiveness. Without proper initial treatment, infection can make seemingly minor wounds fatal. Also, the treatment of more serious battlefield casualties is exacerbated by long evacuation times. This requires battlefield medics and physicians to stabilize patients for extended periods. Because approximately 90 percent of all battlefield deaths occur within the first 30 minutes after an individual is wounded, the ability to rapidly locate, diagnose, and render appropriate initial treatment is vital to reversing the historical outcome of battlefield injuries. The need to optimize such care in the austere far-forward environment with a reduced logistics footprint is the cornerstone around which CCC is built.

The Objective Force and Army transformation are radical changes with a goal of a more responsive, deployable, agile, versatile, lethal, survivable, and sustainable force that will be capable of responding to missions across the full spectrum of conflict. Challenges initiated from Objective Force operational concepts will require revolutionary thinking and products unparalleled in the civilian emergency medical community. The expeditious deployment, wide area coverage, and planned initial independence of Objective Force operations will likely reduce or prevent the availability of prepositioned military hospitals and nonorganic evacuation assets. This situation places even greater emphasis on the medic's ability to perform far-forward stabilization and care of wounded soldiers. But, medical modernization in support of the Army transformation is more than just improving the standard of care. It is the examination of future warfare and new medical operational concepts made possible by advanced technology. As always, the soldier is our primary focus.

Operational Capabilities

With this in mind, we must consider what operational challenges future medical units will face and how medical requirements will be integrated into the Future Combat Systems (FCS). The medical version of the FCS will replace the M577A2 Battalion Aid Station and the M113/A2/A3 Armored Ambulance as the ground medical evacuation and treatment platform. The medical version is envisioned to be precisely the same as the FCS with the exception of mission-unique equipment added following production of the vehicle. A common-chassis approach will reduce the logistical footprint by eliminating separate repair parts and maintenance while FCS significantly enable mobility, survivability, and connectivity to the digitized force. The evacuation module of the medical version will have the capability to carry ambulatory patients and a crew of three in a climate-controlled environment. Essential medical equipment will include onboard oxygen, a litter, a vital signs monitor, and suction capability. The treatment module will allow a protected workspace for the treatment of casualties and provide enough interior workspace to conduct advanced trauma management on one patient while another is prepared for treatment.

Other medical FCS capabilities will help lower the killed-in-action rate, reduce morbidity from wounds, reduce the forward-medical footprint, and increase operational flexibility. These benefits will result from developments such as advanced blood products and volume replacement fluids, new methods to stabilize and treat combat-related trauma, and applications of new drugs to prevent secondary damage to tissues and organs. Also, casualty care and decision-support programs will be enhanced by advances in medical information technology, new noninvasive methods to assess patient status, advanced artificial intelligence software for triage and treatment, new methods to train medics and surgeons, and new ways to apply medical data.

Medical Advances

Developments such as telemedicine for casualty assessment and medical decision support will allow for a broader range of medical skills in the field, better allocation of limited medical assets, reduced need for evacuation, and a faster return to duty. New virtual-reality technologies will enhance diagnosis as well as medical treatment procedures and will enable combat lifesavers, medics, and physicians to develop and maintain critical medical skills during peacetime. Telesurgery with advanced haptics (simulating the touch and feel of the human body) will eventually allow surgeons far removed from the battlefield to perform FCS-based surgery through the use of robotic devices and robotic manipulation.

Robotics, however, will not totally eliminate first responders from the loop. Thus, Warrior Medic is planned as the medical version of the Land Warrior System. Sensor suites will detect wounding events and immediately relay physiological information on each wounded soldier to the medic's computer. Software will allow the medic to instantly obtain the wounded soldier's distance, magnetic compass heading, and vital signs. Artificial intelligence algorithms will perform triage on the casualty and monitor the patient remotely while decision-assist algorithms integrate sensor data into optimal treatment or resuscitation strategies.

After detecting an injury, the medic's first concern for the patient usually is to stop the bleeding. Thus, CCC technologies that focus on methods to stop massive or continuous internal and extremity bleeding are being developed. Technologies include recombinant synthesis and enhancement of natural clotting agents as well as synthesis of artificial clotting agents. One such agent, the fibrin hemostatic bandage, has shown to reduce blood loss by as much as 85 percent in cases of severe bleeding. Other hemostatic technologies include recombinant injectable clotting agents, the one-handed tourniquet, foams and gels (or other formulations that can be used on noncompressible hemorrhages), and high-intensity-focused ultrasound for internal hemorrhages. Such advanced hemostatic products represent a major advance in the ability of combat medics to control bleeding on the battlefield and will, undoubtedly, reduce soldier mortality. Additionally, they may significantly decrease the need for blood on the battlefield.

Notwithstanding advances in hemostasis, current red blood cell products require freezing, thawing, refrigeration, and cross-typing and have a shelf life of only 6 weeks. Longer red blood cell storage of 10-12 weeks will improve medical logistics in the field as well as increase emergency blood supplies at home for disaster relief. Beyond the limitations of shelf life, numerous units are lost annually because of storage bag breakage and embrittlement. Improved blood storage bags are being developed to reduce breakage rates. But even if units do survive transhipment intact, thawing rates preclude the immediate availability of units. New fully automated blood processing systems will thaw a unit of blood in 35 minutes. Other new devices will allow medics to quickly detect infected blood and disinfect it, thus allowing safe transfusions directly from one soldier to another when blood supplies are depleted.

Another CCC emphasis is on low-volume resuscitation strategies and optimized resuscitation fluids to prevent cardiac arrest and rebleeding, and to maintain viability of vital organs. This is critical if evacuation times are greatly prolonged. New resuscitation fluids will augment oxygen-carrying capacities and support cellular function and organ viability during shock. These fluids and/or adjunct drug therapies will extend the duration of shock tolerance for longer periods of time to accommodate delayed evacuation times to reach surgery and resuscitative care. Additionally, while still considered at or near the frontier of development, oxygen-bearing blood substitutes will one day replace the need for red blood cells on the battlefield and the collateral requirements for freezing, thawing, refrigeration, and cross-typing.

Neuroprotection initiatives aim to develop improved technologies to manage head trauma and decrease the medical footprint. This includes advanced, noninvasive sensors and equipment for determining the severity of both closed and penetrating wounds to the head. Also, under development specifically for use by nonphysician first responders is a simple five-point clinical neurological examination that can identify patients suffering from traumatic brain injury. This initiative will also provide the medic with biologics and pharmaceuticals to increase survival by reducing secondary effects of trauma. Such strategies will significantly improve initial diagnosis and the prognosis for functional recovery of the soldier following traumatic brain and spinal cord injuries.

Finally, once stabilized, casualties will need to be cleared from the battlefield. Future patient holding and transport litters must interface seamlessly with the FCS evacuation and treatment vehicles. The need to evacuate patients and treat them en route—up to and including possible surgery—implies the need for highly capable, compact, transportable, individualized medical care. Another new development, the Personal Information Carrier (PIC), will allow a soldier's medical record and treatment history to be downloaded anywhere on the battlefield. The PIC is compatible with all types of computer hardware; it securely stores text, voice, video, and digital data; its memory cells do not require batteries; and its design allows the system to evolve with technology. The Critical Care System for Trauma and Transport (C-STAT) is a patient transport litter that incorporates capabilities normally found only in an intensive care ward (such as ventilation, suction, defibrilation, intravenous/drug infusion, and oxygen) into a unit that is 1 foot deep and as long and wide as the standard NATO litter. The mini-STAT is a preplanned improvement to reduce size, weight, and power demands associated with the C-STAT with little or no loss in capability. Eventually, a future generation transport litter, the transportable patient pod, will allow patients to be sustained autonomously while awaiting evacuation to definitive medical care facilities, while controlled hypothermia and metabolic down-regulation will delay cell death and offset costs associated with delayed evacuation.

Conclusion

Clearly, emerging CCC technologies will help overcome battlefield medical limitations by providing biologics, pharmaceuticals, and devices that enhance the capability to effectively treat casualties as close to the geographic location and time of injury as possible. Individually, these technologies will, without a doubt, improve medical capabilities in the future. Together—as a "system-of-medical-systems"—coupled with the FCS initiatives, these technologies will greatly enhance the Army's Objective Force capability to deliver immediate, far-forward, and en route care for soldiers sustaining life-threatening injuries on the battlefield.

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